

# High Char Flexible Polymers, Phase I Project

SBIR/STTR Programs | Space Technology Mission Directorate (STMD)



## ABSTRACT

TDA Research is proposing to chemically modify the polymer backbone of polymers known to have char yields upwards of 70% at 800+ °C (under inert gas) in order to make the polymers flexible, and possibly elastomeric at or near room temperature. Flexibility is a result of easy rotation around the bonds within a polymer backbone, maintained only in the presence of low crosslink density. Conversely, a high char yield requires very robust bonding, generally with high crosslink density, since floppy, easily broken bonds lead to the evolution of gas, reducing the residual mass. Our modifications will reduce the char yield, but, in this case, even a 10% loss in char yield would still be comparable to the char yield of the inflexible phenolic resins currently in use.

## ANTICIPATED BENEFITS

### To NASA funded missions:

Potential NASA Commercial Applications: Flexible polymers with high char yields are required for advanced ablative thermal protection systems (TPS) used for planetary aerocapture and entry, as well as for Earth return missions. Minimizing TPS weight versus legacy materials can greatly reduce the mission cost, and a suite of new TPS materials has recently been developed at NASA and elsewhere. However, most of these newer, higher-performing TPS have limitations on part size. A spacecraft TPS is therefore made from many individual pieces of material, and the narrow space between parts must be filled to retain performance. There is therefore an acute need for a gap filler that has enough flexibility to prevent cracks from developing during assembly and deployment, and a similarly high char yield so that cracks do not develop when the TPS is exposed to high thermal loads.

### To the commercial space industry:

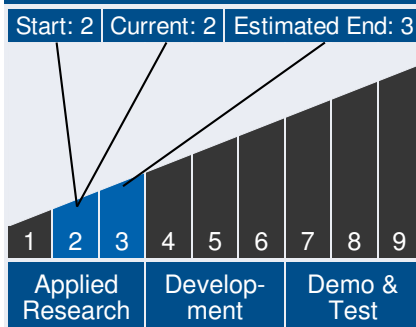
Potential Non-NASA Commercial Applications: Ablative insulation incorporating high char yield polymers is widely used



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## Technology Maturity



## Management Team

### Program Executives:

- Joseph Grant
- Laguduva Kubendran

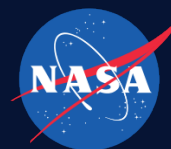
### Program Manager:

- Carlos Torrez

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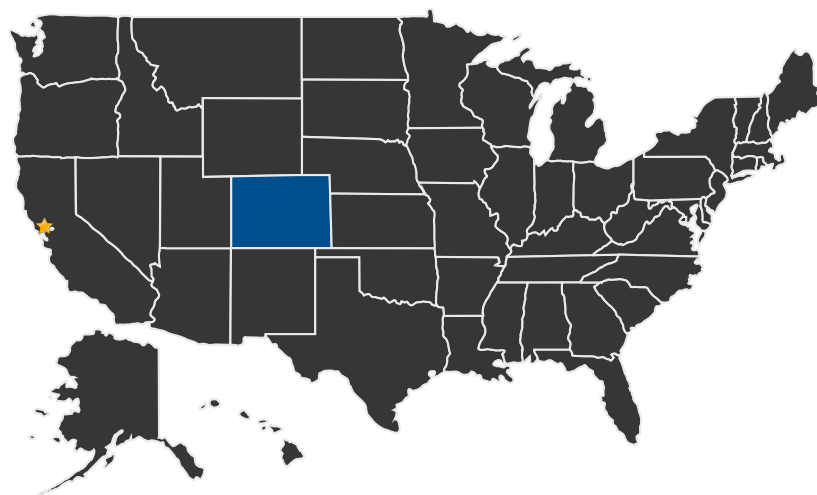
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in a variety of military applications, including the reentry vehicles of ballistic missiles, rocket nozzles, and certain hypersonic vehicle designs. TDA is actively working with the Missile Defense Agency to develop new materials and/or formulations for several of these applications. New programs, such as the Ground-Based Strategic Deterrent, are also emerging, and would benefit from high char polymers with improved processing, environmental stability, and/or decreased thermal conductivity.

## U.S. WORK LOCATIONS AND KEY PARTNERS



■ U.S. States  
With Work

★ **Lead Center:**  
Ames Research Center

### Other Organizations Performing Work:

- TDA Research, Inc. (Wheat Ridge, CO)

## PROJECT LIBRARY

### Presentations

- Briefing Chart
  - (<http://techport.nasa.gov:80/file/23540>)

### Management Team *(cont.)*

#### Principal Investigator:

- Michael Diener

### Technology Areas

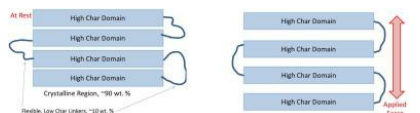
#### Primary Technology Area:

Entry, Descent, and Landing Systems (TA 9)

- └ Aeroassist and Atmospheric Entry (TA 9.1)
  - └ Thermal Protection Systems for Rigid Decelerators (TA 9.1.1)



## IMAGE GALLERY



*High Char Flexible Polymers, Phase I*

## DETAILS FOR TECHNOLOGY 1

### Technology Title

High Char Flexible Polymers, Phase I

### Potential Applications

Flexible polymers with high char yields are required for advanced ablative thermal protection systems (TPS) used for planetary aerocapture and entry, as well as for Earth return missions. Minimizing TPS weight versus legacy materials can greatly reduce the mission cost, and a suite of new TPS materials has recently been developed at NASA and elsewhere. However, most of these newer, higher-performing TPS have limitations on part size. A spacecraft TPS is therefore made from many individual pieces of material, and the narrow space between parts must be filled to retain performance. There is therefore an acute need for a gap filler that has enough flexibility to prevent cracks from developing during assembly and deployment, and a similarly high char yield so that cracks do not develop when the TPS is exposed to high thermal loads.